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(54) VALVE GEAR WITH CYLINDER SUSPENDING MECHANISM OF AN INTERNAL COMBUSTION ENGINE

(75) Inventors: **Norio Takayasu**, Kyoto (JP); **Toshihiko Oka**, Anjyo (JP); **Tetsushi Nagira**, Toyota (JP); **Satoshi Ando**, Aichi (JP); **Shinichi Murata**, Okazaki (JP); **Masanori Tokuhisa**, Rittou (JP)

(73) Assignees: **Mitsubishi Jidosha Kogyo Kabushiki Kaisha**, Tokyo (JP); **Mitsubishi Jidosha Engineering Kabushiki Kaisha**, Aichi (JP)

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Sep. 18, 2003 (JP) 2003-326791

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F01L 1/34 (2006.01)

(52) **U.S. Cl.** **123/90.16**; 123/90.15; 123/90.39

(58) **Field of Classification Search** 123/90.39, 123/90.16, 90.15, 90.31
See application file for complete search history.

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Primary Examiner—Thomas Denion
Assistant Examiner—Zelalem Eshete
(74) *Attorney, Agent, or Firm*—Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A valve gear with a cylinder suspending mechanism of an internal combustion engine, whose entire valve gear mechanism is downsized by efficiently arranging the configuration of the valve gear including the cylinder suspending mechanism. A low-speed drive rocker arm and a high-speed drive rocker arm are disposed in front and at the rear of an intake driven rocker arm so that pistons of low-speed and high-speed cylinder portions arranged side by side in the intake driven rocker arm may be pressed by operating operation arm portions extending from the respective drive rocker arms, to thereby arrange the low-speed and high-speed cylinder portions and the low-speed and high-speed drive rocker arms around the intake driven rocker arm to gather in one place.

13 Claims, 8 Drawing Sheets

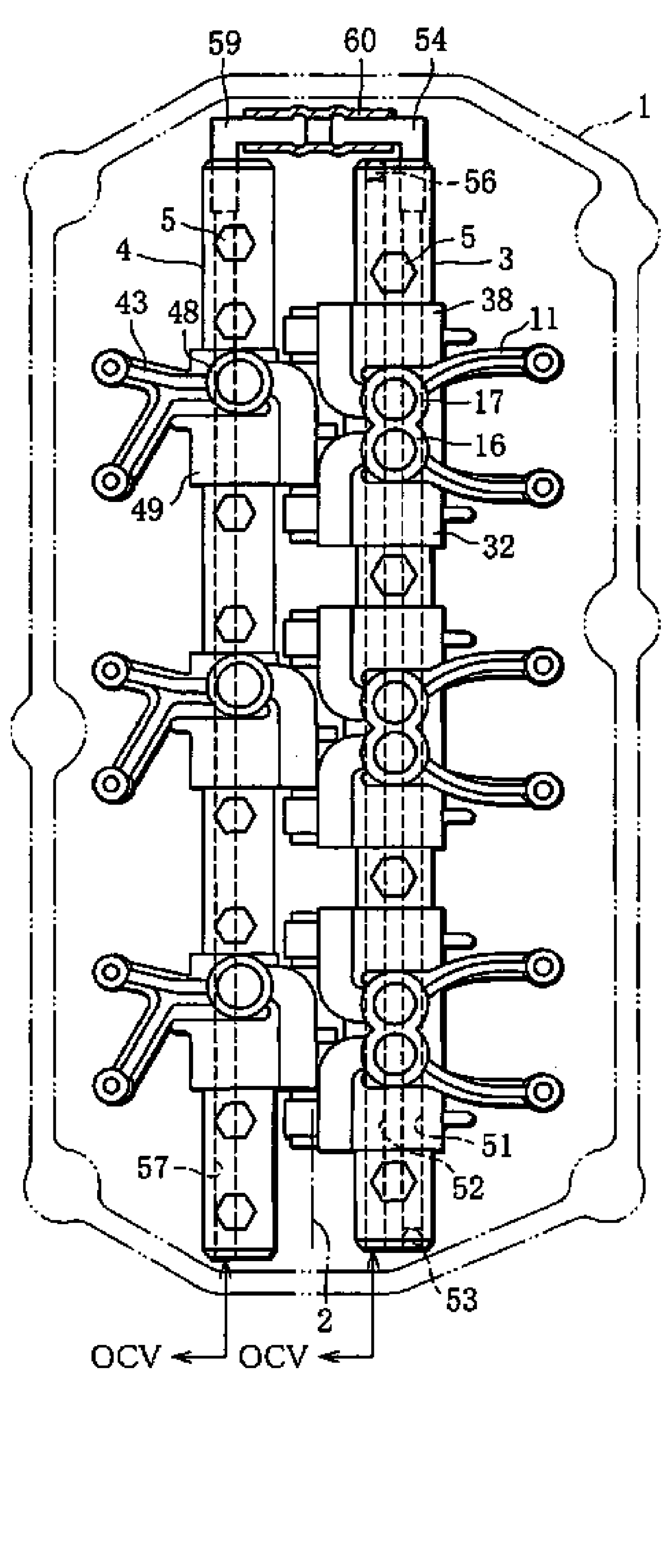


FIG. 1

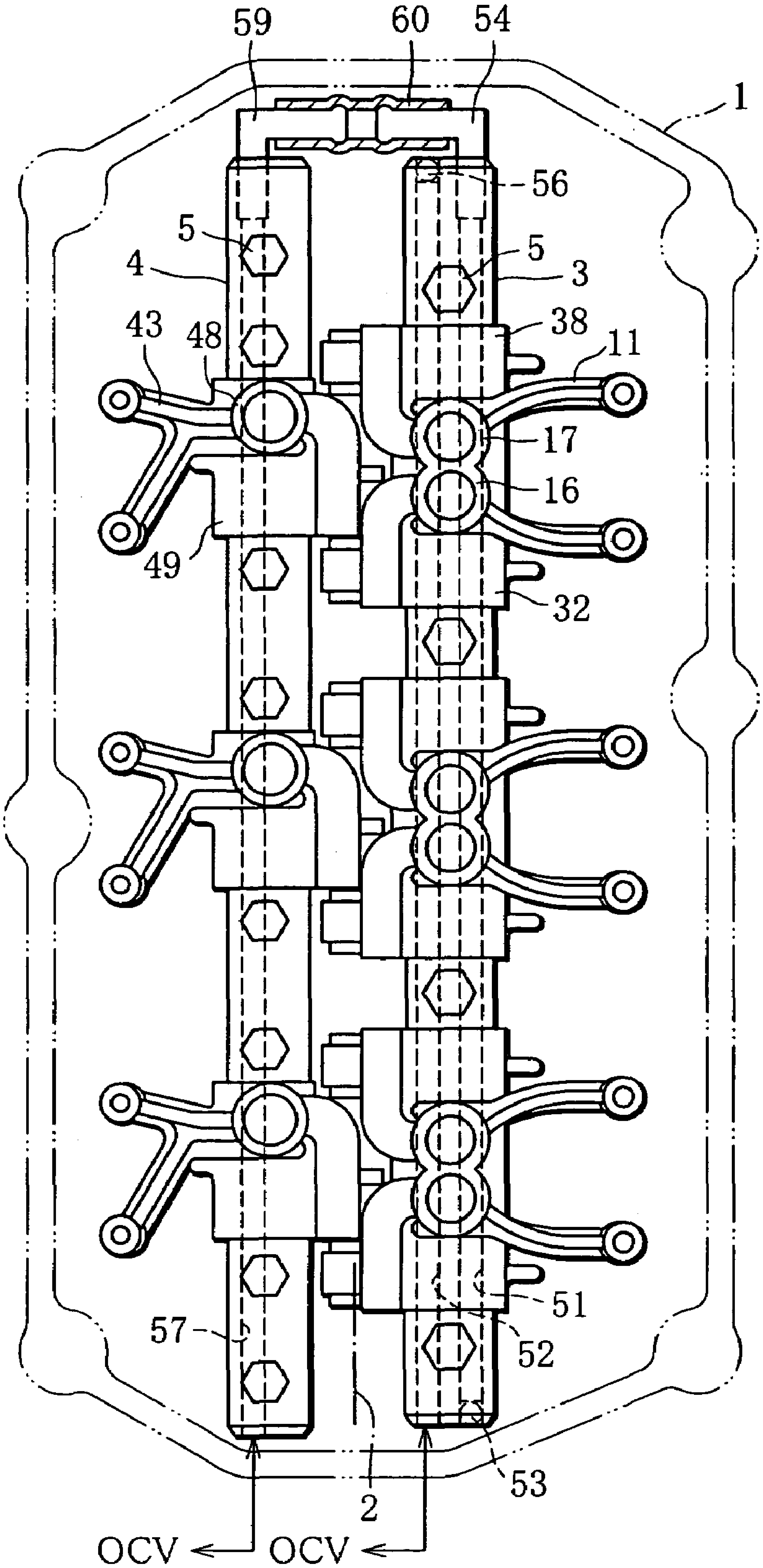
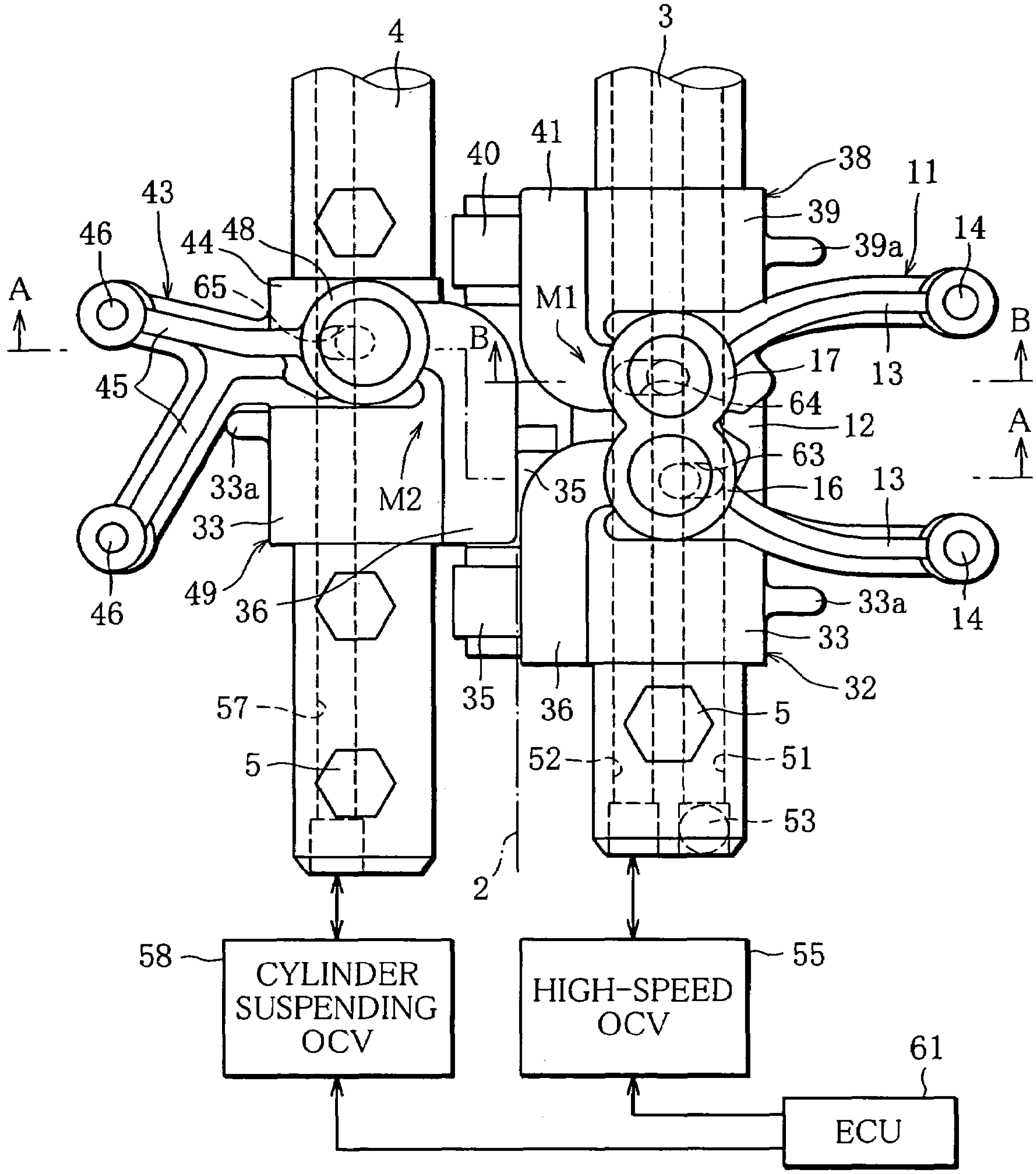


FIG. 2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12
A
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33a
M2
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33a
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CYLINDER
SUSPENDING
OCV
HIGH-SPEED
OCV
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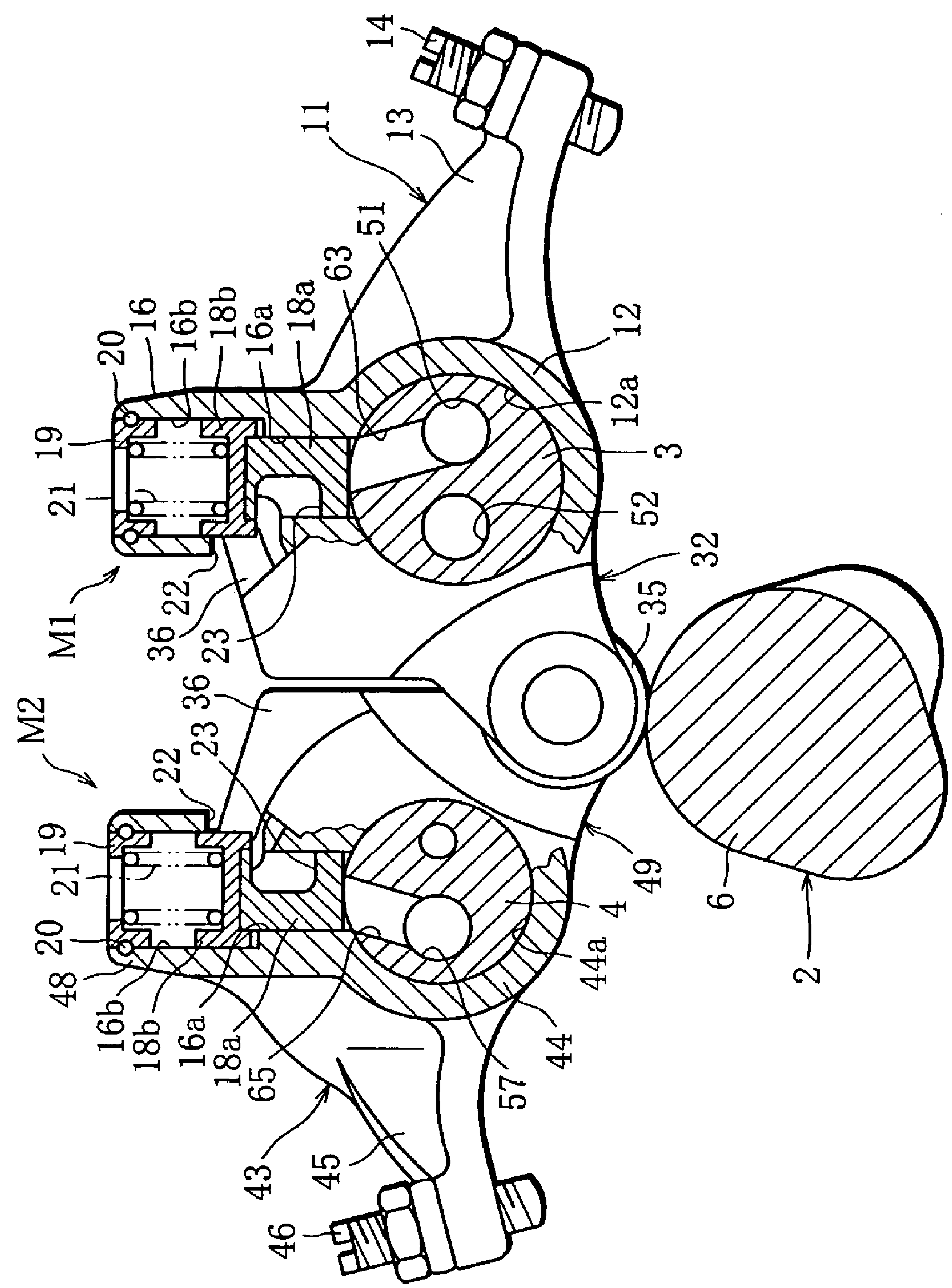
61
ECU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11
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63
12
16
16b
18b
16a
18a
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12a
3
52
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22
M1
36
23
35
M2
36
23
22
19
21
20
48
16b
18b
16a
18a
65
57
44
44a
4
49
6
2
43
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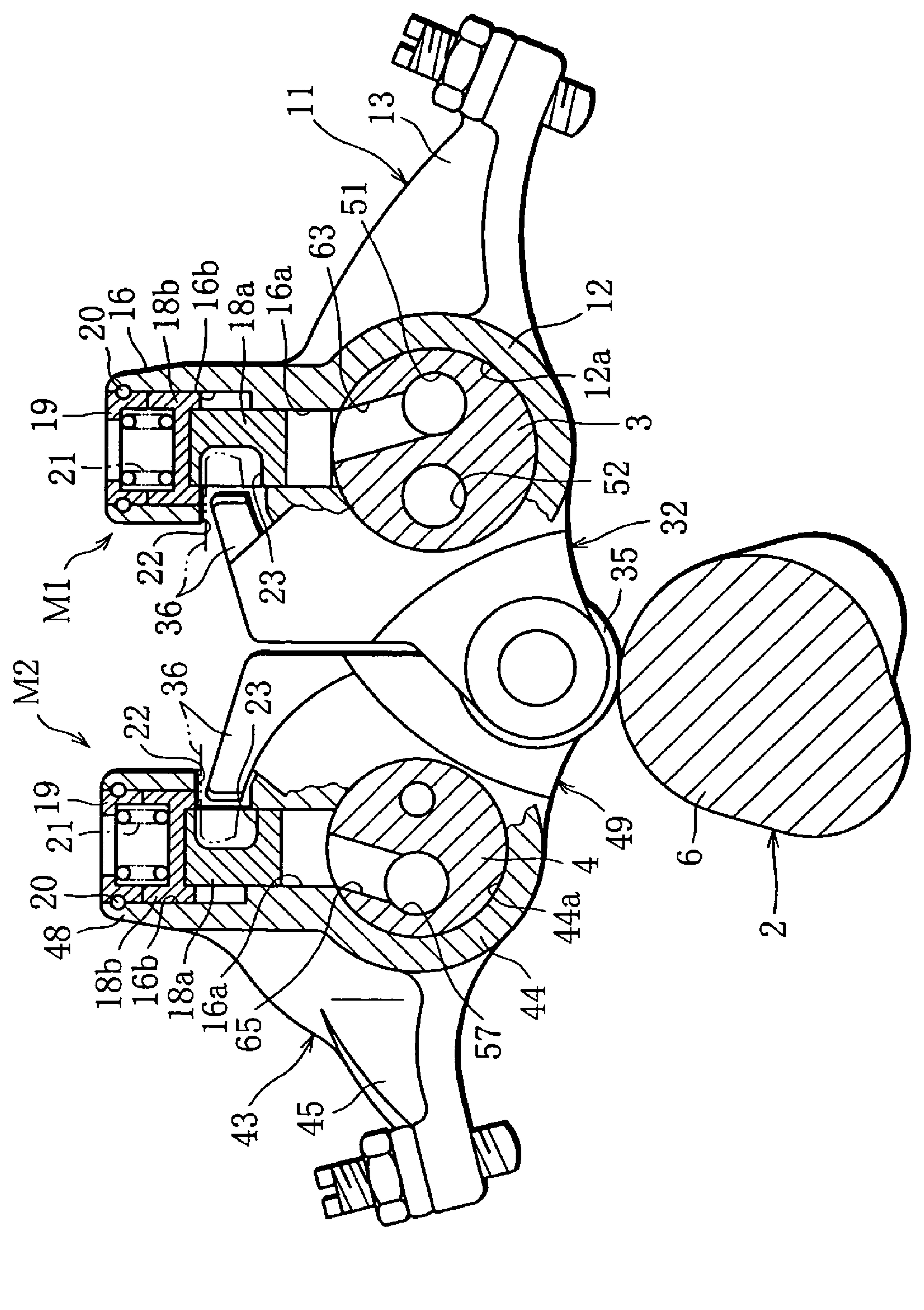
46

FIG. 3

FIG. 4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22
36
23
M2
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36
23
19
21
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18b
16b
18a
16a
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44a
4
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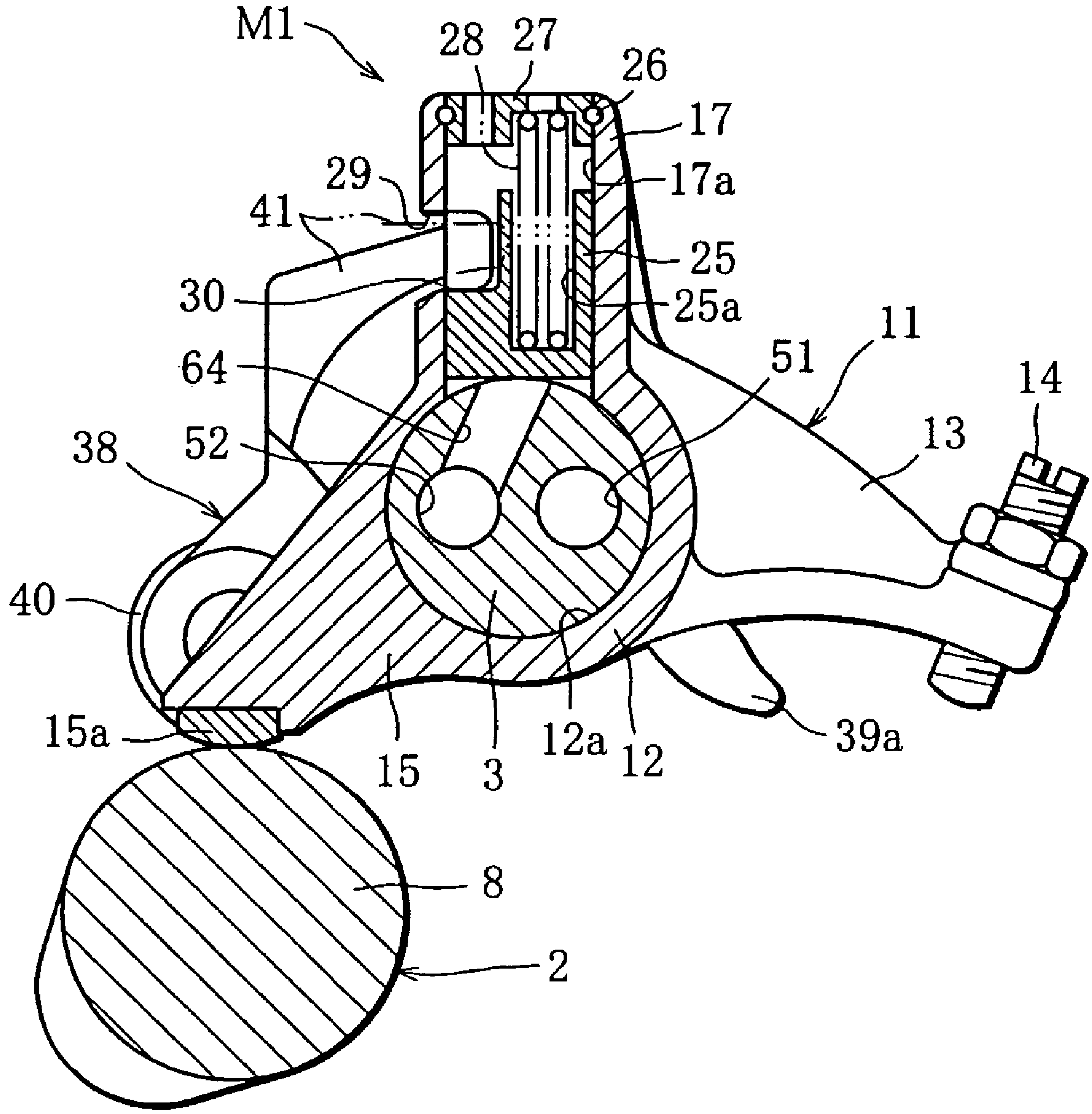
FIG. 5


M1
28
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17a
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41
25
30
25a
11
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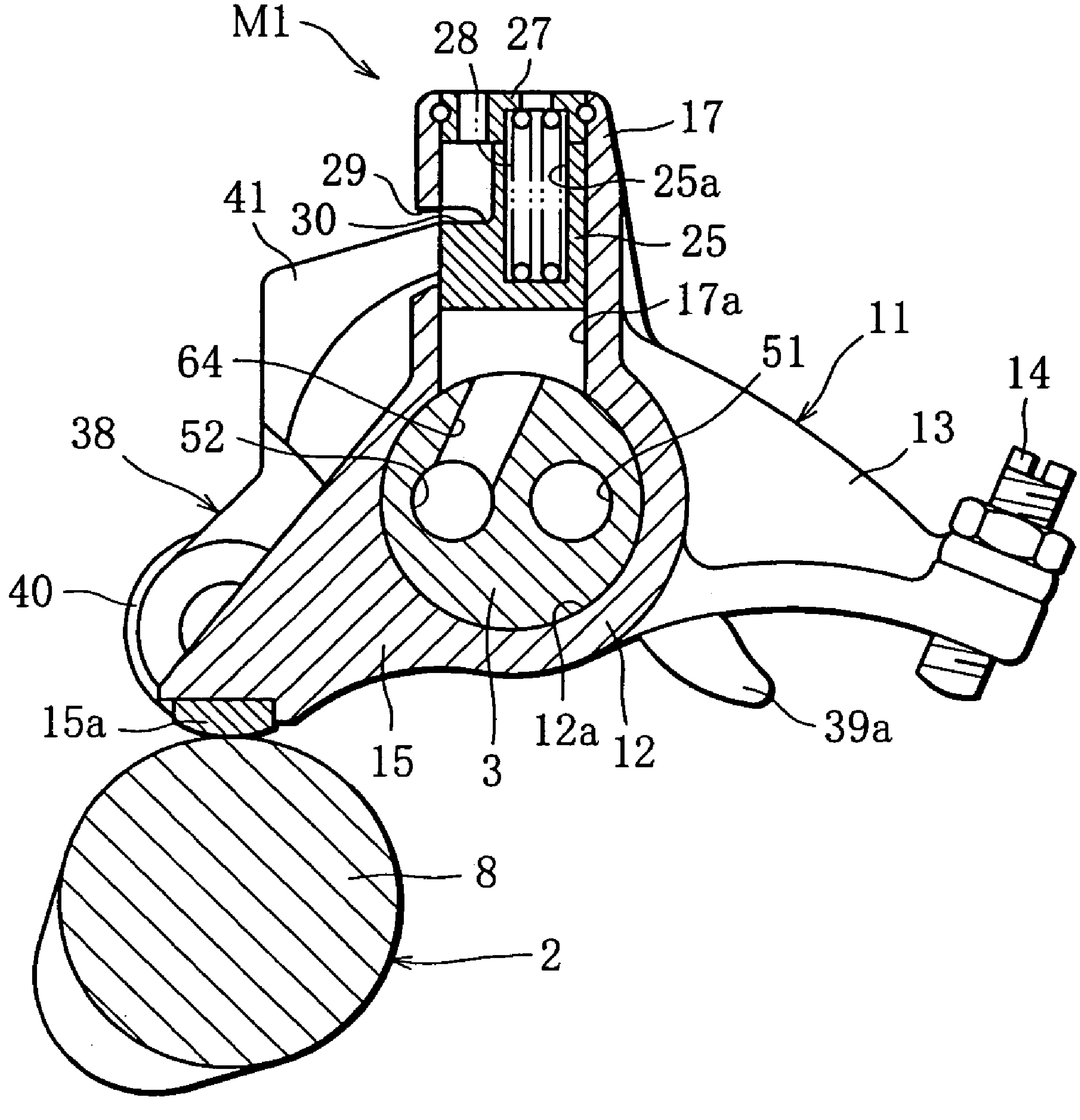
3
12a
12
39a
8
2

FIG. 6


M1
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15
3
12a
12
39a
8
2

FIG. 7

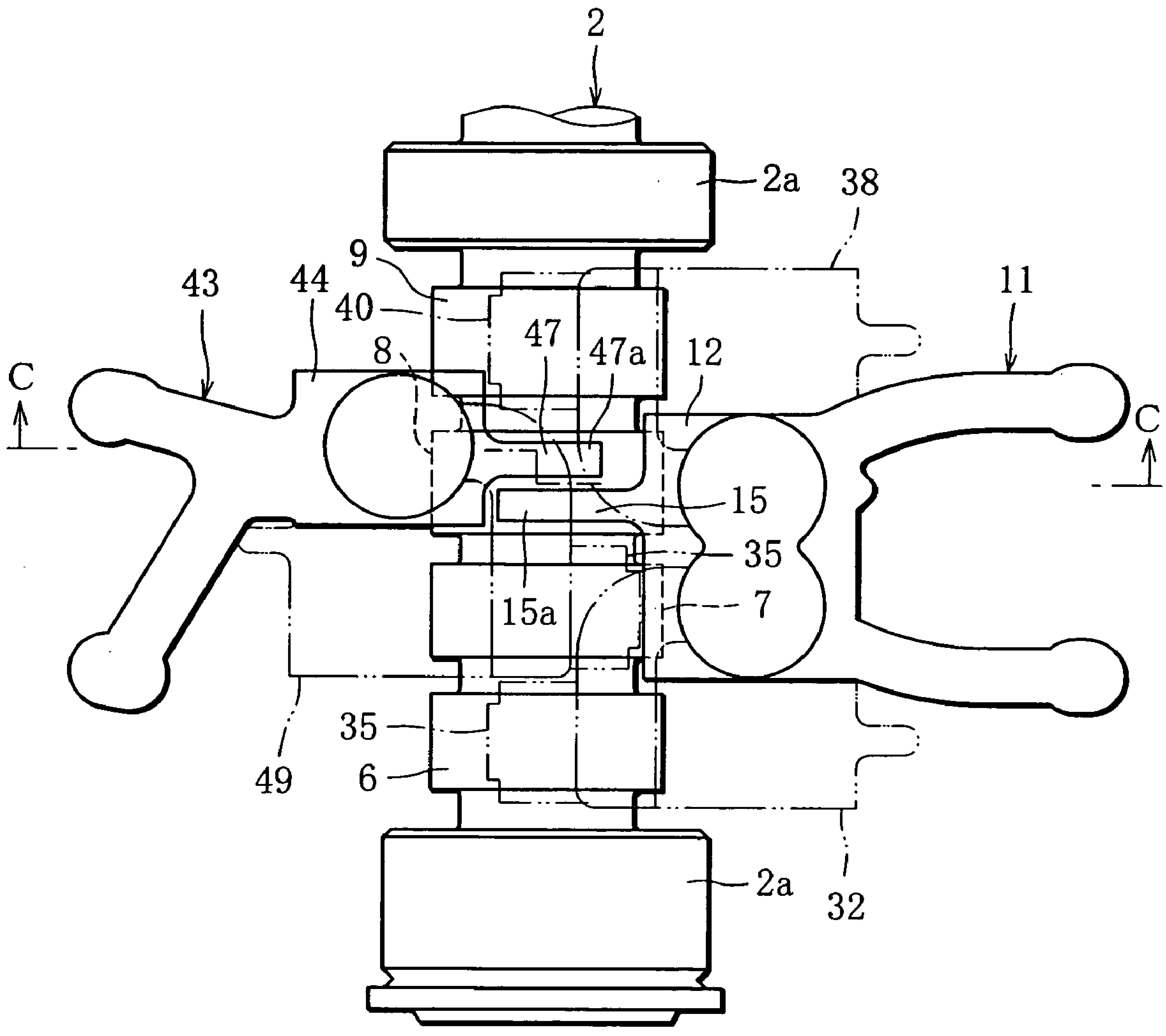
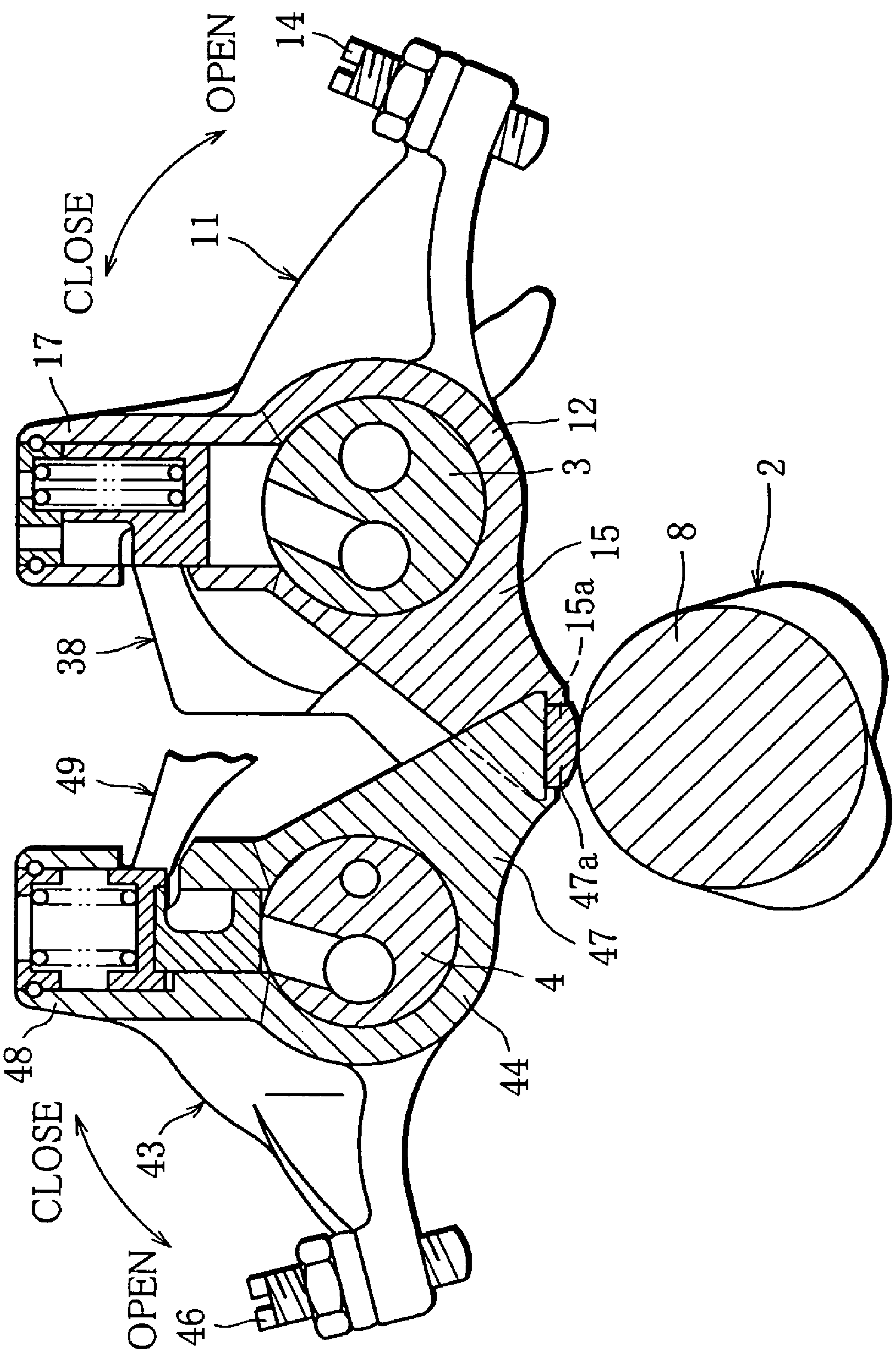


FIG. 8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15a
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47a
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CLOSE
OPEN
46

VALVE GEAR WITH CYLINDER SUSPENDING MECHANISM OF AN INTERNAL COMBUSTION ENGINE

CROSS-REFERENCE TO RELATED APPLICATIONS

This Nonprovisional application claims priority under 35 U.S.C. §119(a) on Patent Application Nos. 2003-326790 and 2003-326791 filed in Japan on Sep. 18, 2003, the entire contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a valve gear with a cylinder suspending mechanism of an internal combustion engine (hereinafter referred to as engine).

2. Description of the Related Art

To realize the most suitable engine output characteristics according to an operation region, various types of engines, which perform the switching of the opening period or the lift amount of intake and exhaust valves, and the like, have been suggested (for instance, refer to Unexamined Japanese Patent Publication Nos. 2001-41017 and 2002-227624).

In the engine disclosed in Publication No. 2001-41017, a driven rocker arm supported by a rocker shaft is oscillated by a first cam to drive an intake valve to be open or close, and a drive rocker arm formed adjacent to the driven rocker arm and supported by the rocker shaft is oscillated by a second cam. A piston is fitted into a cylinder formed in the driven rocker arm so as to be slidable by hydraulic pressure, while in the drive rocker arm, an engaging projection that is engageable with the piston along with the oscillation is formed.

In a low revolution region of the engine, for instance, the piston of the driven rocker arm is switched to its lower position to cause the engaging projection of the drive rocker arm to strike at the air, to thereby open and close the intake valve along the shape of the first cam by using the driven rocker arm. In a high revolution area of the engine, on the contrary, the piston of the driven rocker arm is switched to its upper position to be pressed by the engaging projection of the drive rocker arm to oscillate the driven rocker arm with the drive rocker arm, to thereby open and close the intake valve along the shape of the second cam.

In the engine disclosed in Publication No. 2002-227624, a first rocker arm corresponding to a low-speed cam, a second rocker arm corresponding to a high-speed cam, and a third rocker arm corresponding to a suspension cam are supported in an intake-side rocker shaft, and a pair of intake valves is driven to open or close in liaison with the first and third rocker arms. There is provided a switch pin in each rocker arm to be slidable by hydraulic pressure in the axial direction of the rocker shaft. The rocker arms are connected with or disconnected from one another according to the sliding position of the switch pins.

In the low revolution region of the engine, for example, the connections of the rocker arms are released by the switch pins. One of the intake valves is driven to be open or close along the low-speed cam through the first rocker arm, and the other intake valve is practically kept closed by the suspension cam through the third rocker arm. In the high revolution region of the engine, the rocker arms are connected by the switch pins, and all the rocker arms are integrally oscillated by the high-speed cam to drive both the intake valves to be open or close along the high-speed cam.

As described above, in the engine disclosed in Publication No. 2001-41017, the switching is carried out in two operation states in each of which the intake valve is driven to be open or close by means of a corresponding one of the first and second cams. In the engine disclosed in Publication No. 2002-227624, the switching is performed in two operation states in one of which the intake valves are driven to be open or close by the low-speed cam and the suspension cam and in the other of which the intake valves are driven to be open or close by the high-speed cam. It has been desired to provide a cylinder suspending function for suspending certain cylinders in addition to the above-stated functions.

To add the cylinder suspending function, however, it is required to add a mechanism for stopping the oscillation of the rocker arms connected to the intake valves (namely the driven rocker arm in Publication No. 2001-41017 and the first and third rocker arms in Publication No. 2002-227624). This generates a problem that, with technologies disclosed in Publication Nos. 2001-41017 and 2002-227624, the entire valve gear would be enlarged in size as the configuration thereof becomes complicated.

A valve gear with a cylinder suspending mechanism requires that intake and exhaust valves of suspending cylinders be kept closed. For instance, as for an SOHC-type engine in which intake and exhaust valves are driven to open or close by a single camshaft, a circular suspension cam is provided on the camshaft, and intake and exhaust rocker arms are brought into contact with the suspension cam when cylinders are inoperative, to thereby hold the intake and exhaust valves closed. It is required in such an engine to form as many suspension cams as rocker arms on the camshaft. This causes problems, however, that the camshaft has to be long in its entire length, that the manhours of processing the camshaft are increased, and so on. Therefore, countermeasures against these problems have been suggested (refer to Unexamined Japanese Patent Publication No. 2002-201921 (FIG. **2**)).

Publication No. 2002-201921 discloses an engine in which intake-side and exhaust-side rocker shafts each support a pair of drive rocker arms corresponding to a pair of intake and exhaust valves. According to the sliding movement of switch pins, the drive rocker arms are connected with or disconnected from their respective free rocker arms that are each oscillated by an intake cam, real suspension cam, and exhaust cam of a camshaft, to thereby arbitrarily open and close the intake and exhaust valves. The intake-side and exhaust-side drive rocker arms are located such that the intake-side drive rocker arms substantially correspond to their respective exhaust-side drive rocker arms in the axial direction of the rocker shaft, and a pair of suspension cams is formed on the camshaft so as to be located in between the corresponding intake and exhaust drive rocker arms. At the time of cylinder suspension, the corresponding intake and exhaust drive rocker arms are brought into contact with the common suspension cam, to thereby keep the intake and exhaust valves closed.

In an engine disclosed in Unexamined Japanese Patent Publication No. 2002-201921, suspension cams are reduced in number by half by providing a common suspension cam to intake and exhaust drive rocker arms. On the other hand, however, a pair of suspension cams is indispensable per cylinder due to constraints on layout of a cylinder suspending mechanism.

More specifically, as illustrated in FIG. **2** of the publication, a free rocker arm oscillated by an intake cam is disposed in between a pair of intake-side drive rocker arms, and another free rocker arm oscillated by an exhaust cam is arranged in between a pair of exhaust-side drive rocker arms. Such layout makes it impossible to substitute a single suspension cam for a pair of suspension cams, that is, to bring all the intake and exhaust drive rocker arms into contact with the single suspension cam, since the free rocker arms and the intake and exhaust cams cause obstruction.

Accordingly, the engine disclosed in the publication requires that a pair of suspension cams be formed on the camshaft per cylinder, which discourages full achievement of reduction of a camshaft's entire length and a reduction in manhours of processing the camshaft.

SUMMARY OF THE INVENTION

The present invention providing provides a valve gear with a cylinder suspending mechanism of an internal combustion engine, whose entire valve gear mechanism is downsized by efficiently arranging the configuration of the valve gear including the cylinder suspending mechanism.

The valve gear with a cylinder suspending mechanism of an internal combustion engine according to the present invention comprises a first rocker arm having a tip end connected to either one of intake and exhaust valves and pivotably supported on a first rocker shaft, a second rocker arm located at one side of the first rocker arm, pivotably supported on the first rocker shaft, and driven by a first cam formed in a camshaft, a third rocker arm located at the other side of the first rocker arm, pivotably supported on the first rocker shaft, and driven by a second cam formed in the cam shaft and having a cam shape different from the first cam, a first switching mechanism for switching connection and disconnection of the first rocker arm with respect to the second or third rocker arm, and control means for controlling the switching of the first switching mechanism, in which the first switching mechanism includes a first piston slidably fitted into a first cylinder formed in the first rocker arm, a second piston slidably fitted into a second cylinder formed in the first rocker arm, a first engaging projection extending from the second rocker arm and formed to be engageable with the first piston, and a second engaging projection extending from the third rocker arm and formed to be engageable with the second piston, and the first and second pistons are switched between an engaging position and a non-engaging position with respect to the first and second engaging projections.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus, are not limitative of the present invention, and wherein:

FIG. **1** is a plan view showing a cylinder head having a valve gear with a cylinder suspending mechanism of an engine according to one embodiment;

FIG. **2** is an enlarged partial plan view showing details of the valve gear for one cylinder;

FIG. **3** is a cross-sectional view taken along line A—A of FIG. **2**, showing an operating state of a low-speed cam and an exhaust cam;

FIG. **4** is a cross-sectional view taken along line A—A of FIG. **2**, showing a suspending state of the low-speed cam and the exhaust cam;

FIG. **5** is a cross-sectional view taken along line B—B of FIG. **2**, showing a suspending state of a high-speed cam;

FIG. **6** is a cross-sectional view taken along line B—B of FIG. **2**, showing an operating state of the high-speed cam;

FIG. **7** is an enlarged partial plan view showing the positional relation of drive rocker arms and driven rocker arms with respect to the cams; and

FIG. **8** is a cross-sectional view taken along line C—C of FIG. **7**.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

A valve gear with a cylinder suspending mechanism of an engine according to an embodiment of the present invention will be described below.

The engine according to the present embodiment is constructed as a V-six cylinder gasoline engine having four valves per cylinder, and is designed to be capable of switching among a high-speed mode for realizing particularly high engine output, a low-speed mode for dealing with normal engine output, and a cylinder suspending mode for suspending cylinders located on one of two banks. Therefore, valve gears of both banks each have a switching mechanism for switching the low-speed mode and the high-speed mode, and one of the banks is provided with a cylinder suspending mechanism. First of all, an explanation will be provided about a configuration of the bank having the cylinder suspending mechanism (hereinafter referred to as a suspension cylinder bank, and the opposite one as a non-suspension cylinder bank).

Suspension Cylinder Bank

FIGS. **1** through **8** show a cylinder head of the suspension cylinder bank. It is assumed here that the upper and lower direction in FIG. **1** represents the longitudinal direction of the engine, the right side of the cylinder head is an intake side, and the left side is an exhaust side. There is disposed a cylinder head of the non-suspension cylinder bank on the right of the cylinder head of the suspension cylinder bank.

As illustrated in FIGS. **2**, and **7**, a camshaft **2** of the valve gear is disposed in the substantial middle of a cylinder head **1** to extend in a longitudinal direction. The camshaft **2** has journal portions **2***a* supported by respective cylinder head journals, not shown, to be driven by a crankshaft to rotate in synchronization. An intake rocker shaft **3** (first rocker shaft) is arranged on the upper right side of the camshaft **2**, and an exhaust rocker shaft **4** (second rocker shaft) on the upper left side of the camshaft **2**. The rocker shafts **3** and **4** are appropriately fixed onto the cylinder head **1** with bolts **5** in parallel with the camshaft **2**.

Cylinders are arranged in a row along the camshaft **2** in the longitudinal direction. The valve gear for one of the cylinders will be described below, and it should be noted that the valve gears for the other cylinders each have the identical configuration. As shown in FIG. **7**, formed in between two adjacent journal portions **2***a* of the camshaft **2** are cams for one cylinder, including a low-speed-side intake cam **6** (first cam, and hereinafter abbreviated as low-speed cam), an exhaust cam **7** (third cam), a suspension cam **8** (fourth cam), and a high-speed-side intake cam **9** (second cam, and hereinafter abbreviated as high-speed cam) arranged in the order named from the front side. Configurations of intake-side and exhaust-side valve gears driven by the cams **6** through **9** and configurations of oil paths for switching the valve gears will be described below in due order.

Intake-Side Valve Gear

As illustrated in FIGS. **2** and **3**, the intake rocker shaft **3** is fitted in a bearing bore **12***a* formed in a boss portion **12** of an intake driven rocker arm **11** (first rocker arm), and the entire intake driven rocker arm **11** can be oscillated around the intake rocker shaft **3**. Two valve-side arm portions **13** formed into a biforked shape extending from the boss portion **12** (first support portion) in a rightward direction. Provided to a tip end of each valve-side arm portion **13** is an adjust bolt **14** for valve clearance adjustment, which corresponds to an intake valve, not shown, located on the cylinder head **1**.

Referring to FIGS. **7** and **8**, a cam-side arm portion **15** (first contact portion) extends from the boss portion **12** in a leftward direction, and a sliding-contact portion **15***a* formed in a tip end of the cam-side arm portion **15** is in contact with the suspension cam **8**. If the intake driven rocker arm **11** is oscillated clockwise while the sliding-contact portion **15***a* of the cam-side arm portion **15** is in contact with the suspension cam **8**, the intake valves are opened against valve springs through the adjust bolts **14** of the valve-side arm portions **13**. Hereinafter, an oscillating direction of members constructing the intake-side valve gear, including the intake driven rocker arm **11**, an after-mentioned low-speed drive rocker arm **32**, an after-mentioned high-speed drive rocker arm **38** and the like, is defined as a valve-opening direction if the oscillating direction is clockwise, and a valve-closing direction if counterclockwise.

As illustrated in FIGS. **2**, **3**, and **5**, on the boss portion **12** of the intake driven rocker arm **11**, a cylindrical low-speed cylinder portion **16** and a cylindrical high-speed cylinder portion **17** are integrally formed alongside. Formed in the low-speed cylinder portion **16** is a lower cylinder **16***a* (one half portion of a first cylinder) with a small diameter and an upper cylinder **16***b* (the other half portion of the first cylinder) with a large diameter, each having a circular shape in section. The lower cylinder **16***a* and the corresponding upper cylinder **16***b* are formed continuously in a vertical direction. The lower cylinder **16***a* has a lower end that is open in an inner circumferential surface of the bearing bore **12***a* of the boss portion **12**, and the upper cylinder **16***b* has an upper end that is open upward.

Disposed in the lower cylinder **16***a* is a lower piston **18***a* (a second portion of a first piston). The lower piston **18***a* can slide in the lower cylinder **16***a* in the vertical direction while being restricted in rotation around the axis of the lower cylinder **16***a* by a restriction pin, not shown. In the upper cylinders **16***b*, there is located an upper piston **18***b* (a first portion of the first piston), which is also slidable in the upper cylinder **16***b* in the vertical direction. The upper piston **18***b* is made of a material having higher rigidity than a material used for the lower piston **18***a*.

A cap **19** is pressed into an opening of the upper cylinder **16***b* and prevented by a snap ring **20** from being detached therefrom. In the upper cylinder **16***b*, there is interposed a compression spring **21** between the cap **19** and the upper piston **18***b*. As shown in FIG. **3**, the lower piston **18***a* and the upper piston **18***b* are downwardly biased by the compression spring **21** all the time, thereby being held in respective lower positions (engaging positions) which bring a lower surface of the lower piston **18***a* into contact with an outer circumferential surface of the intake rocker shaft **3**. As illustrated in FIG. **4**, when the lower piston **18***a* and the upper piston **18***b* slide upward from the lower positions in the cylinders **16***a* and **16***b*, resisting the compression spring **21**, an upper portion of the upper piston **18***b* is brought into contact with a lower portion of the cap **19**. Accordingly, the lower piston **18***a* and the upper piston **18***b* are switched to respective upper positions (non-engaging positions).

An operation window **22** is formed in a left surface of the low-speed cylinder portion **16**, that is, in a side facing the camshaft **2**, and a run-off **23** is formed as a recess in a left surface of the lower piston **18***a*. When the pistons **18***a* and **18***b* are in the upper positions shown in FIG. **4**, the run-off **23** of the lower piston **18***a* is exposed leftward through the operation window **22**. In the lower positions shown in FIG. **3**, an outer circumferential surface of the upper piston **18***b* is exposed leftward through the operation window **22**.

Referring to FIG. **5**, a cylinder **17***a* (second cylinder) having a circular shape in section is formed in the high-speed cylinder portion **17** in the vertical direction. The cylinder **17***a* has a lower end that is open in the inner circumferential surface of the bearing bore **12***a* of the boss portion **12** and an upper end that is open upward fitted in the cylinder **17***a* is a piston **25** (second piston). The piston **25** can slide in the cylinder **17***a* in the vertical direction while being restricted in rotation around the axis of the cylinder **17***a* by a restriction pin, not shown. The piston **25** is made of the same material as one used for the upper piston **18***b* of the low-speed cylinder portion **16**, to thereby secure equivalent rigidity.

As is the case with the low-speed cylinder portion **16**, a cap **27** is fitted in an opening of the cylinder **17***a* with a snap ring **26**, and a compression spring **28** is interposed between the cap **27** and the piston **25**. As illustrated in FIG. **5**, the piston **25** is constantly biased in the downward direction by the compression spring **28** and maintained in a lower position (non-engaging position) which brings a lower surface thereof into contact with the outer circumferential surface of the intake rocker shaft **3**. Referring to FIG. **6**, when the piston **25** upwardly slides from the lower position in the cylinder **17***a*, resisting the compression spring **28**, an upper portion of the piston **25** is brought into contact with a lower portion of the cap **27**, which switches the piston **25** to an upper position (engaging position).

There is formed an operation window **29** in a left surface of the high-speed cylinder portion **17**, and also a run-off **30** as a recess in a left surface of the piston **25**. When the piston **25** is located in the lower position shown in FIG. **5**, the run-off **30** of the piston **25** is exposed leftward through the operation window **29**. When the piston **25** is placed in the upper position shown in FIG. **6**, an outer circumferential surface of the piston **25** is exposed through the operation window **29**. The compression spring **28** of the high-speed cylinder portion **17** has a smaller diameter but a greater length than the compression spring **21** of the low-speed cylinder portion **16**, to thereby secure a prescribed biasing force applied to the piston **25**. Moreover, the compression spring **28** is located offset with respect to an axis of the high-speed cylinder portion **17** and held in a spring hole **25***a* that is formed in the piston **25** to prevent from being bent by compression.

As illustrated in FIGS. **2** and **3**, a boss portion **33** of the low-speed drive rocker arm **32** (second rocker arm) is located in front of the intake driven rocker arm **11** on the intake rocker shaft **3** and pivotably supported on the intake rocker shaft **3**. In the right side of the boss portion **33**, there is a bias portion **33***a* protruding downward. The entire low-speed drive rocker arm **32** is biased in a valve-closing direction by a bias spring, not shown, coupled with the bias portion **33***a*. Accordingly, a roller **35** disposed in the left side is brought into contact with the low-speed cam **6** as shown in FIG. **7**.

An operation arm portion **36** (first engaging projection) extends from an upper-side position of the roller **35** of the low-speed drive rocker arm **32** in a rearward direction along the axis of the camshaft **2**. The operation arm portion **36** has a tip end that is bent into an L-shape toward the intake driven rocker arm **11** located in the right side thereof, to thereby face the operation window **22** of the low-speed cylinder portion **16**. The low-speed drive rocker arm **32** is oscillated along the shape of the low-speed cam **6** while rotating the roller **35** on the low-speed cam **6** that is in rotation. In a base circular zone (zone in which a lift amount is 0) of the low-speed cam **6**, the low-speed drive rocker arm **32** is oscillated in the valve-closing direction to separate the tip end of the operation arm portion **36** from the operation window **22** in the leftward direction as shown by a solid line in FIG. **4**. In a lift zone of the low-speed cam **6**, on the contrary, the low-speed drive rocker arm **32** is oscillated in a valve-opening direction to insert the tip end of the operation arm portion **36** into the operation window **22** as shown by a chain double-dashed line in FIG. **4**.

There is formed a boss portion **39** in the high-speed drive rocker arm **38** (third rocker arm), the boss portion **39** being located at the rear of the intake driven rocker arm **11** on the intake rocker shaft **3** and pivotably supported on the intake rocker shaft **3**. As is the case with the low-speed drive rocker arm **32**, the high-speed drive rocker arm **38** is biased by a bias spring, not shown, in the valve-closing direction through a bias portion **39***a*, to thereby bring a roller **40**, which is provided in the left side, into contact with the high-speed cam **9** as illustrated in FIG. **7**.

An operation arm portion **41** (second engaging projection) extends from an upper-side position of the roller **40** of the high-speed drive rocker arm **38** in a frontward direction along the axis of the camshaft **2**. The operation arm portion **41** has a tip end that is bent into an L-shape toward the intake driven rocker arm **11** located in the right side thereof, to thereby face the operation window **29** of the high-speed cylinder portion **17**. Like the low-speed drive rocker arm **32**, the high-speed drive rocker arm **38** is oscillated along a shape of the high-speed cam **9** while rotating the roller **40** on the high-speed cam **9**. In a base circular zone of the high-speed cam **9**, the high-speed drive rocker arm **38** is oscillated in the valve-closing direction to separate the tip end of the operation arm portion **41** from the operation window **29** in the leftward direction as shown by a solid line in FIG. **5**. In a lift zone of the high-speed cam **9**, on the contrary, the high-speed drive rocker arm **38** is oscillated in the valve-opening direction to insert the tip end of the operation arm portion **41** into the operation window **29** as shown by a chain double-dashed line in FIG. **5**.

According to the present embodiment, a first switching mechanism **M1** is constituted by the lower and upper pistons **18***a* and **18***b* of the low-speed cylinder portion **16**, the piston **25** of the high-seed cylinder portion **17**, the operation arm portion **36** of the low-speed drive rocker arm **32**, and the operation arm portion **41** of the high-speed drive rocker arm **38**.

Exhaust-Side Valve Gear

Contrary to the intake-side valve gear, the exhaust-side valve gear does not include the high-speed cylinder portion **17** of the intake driven rocker arm **11** and the high-speed drive rocker arm **38** corresponding thereto. A configuration of the exhaust-side valve gear will be described below.

As illustrated in FIGS. **2** and **3**, the exhaust rocker shaft **4** is fitted in a bearing bore **44***a* of a boss portion **44** (second support portion) of an exhaust driven rocker arm **43** (fourth rocker arm). The entire exhaust driven rocker arm **43** can be oscillated around the exhaust rocker shaft **4**. Extending leftward from the boss portion **44** are two valve-side arm portions **45** formed into a biforked shape. Each valve-side arm portion **45** has a tip end provided with an adjust bolt **46** corresponding to an exhaust valve, not shown, attached onto the cylinder head **1**.

Referring to FIG. **7**, the boss portion **12** of the intake driven rocker arm **11** and the boss portion **44** of the exhaust driven rocker arm **43** are arranged in the right and left sides of the camshaft **2**, respectively. In addition, the boss portions **12** and **44** partly overlap each other in an axial direction of the camshaft **2**. As shown in FIGS. **7** and **8**, a cam-side arm portion **47** (second contact portion) extends from the boss portion **44** in the rightward direction. Formed in a tip end of the cam-side arm portion **47** is a sliding-contact portion **47***a*, which is in contact with the suspension cam **8** while avoiding interference with the sliding-contact portion **15***a* of the intake driven rocker arm **11**. Herein, the cam-side arm **15** of the intake driven rocker arm **11** and the cam-side arm **47** of the exhaust driven rocker arm **43** are located side by side on the suspension cam to overlap each other, as viewed in the axial direction of the camshaft **2**.

In the above-described state, if the exhaust driven rocker arm **43** is oscillated counterclockwise, the exhaust valves are opened against the valve springs through the adjust bolts **46** of the valve-side arm portions **45**. Hereinafter, an oscillating direction of members constructing the exhaust-side valve gear, including the exhaust driven rocker arm **43**, an after-mentioned exhaust drive rocker arm **49** and the like, is defined as a valve-opening direction if the oscillating direction is counterclockwise, and a valve-closing direction if clockwise.

As illustrated in FIGS. **2** and **3**, an annular cylinder portion **48** is integrally formed on the boss portion **44** of the exhaust driven rocker arm **43**. The cylinder portion **48** has a configuration symmetrical to the low-speed cylinder portion **16** of the intake driven rocker arm **11** as shown in FIG. **3**.

The cylinder portion **48** will be roughly described below with the same reference numerals as those for the low-speed cylinder portion **16**. The lower piston **18***a* (a second portion of a third piston) and the upper piston **18***b* (a first portion of the third piston) are fitted in the lower cylinder **16***a* (one half of a third cylinder) and the upper cylinder **16***b* (another half of the third cylinder) of the cylinder portion **48**, respectively, to be slidable in the vertical direction. The pistons **18***a* and **18***b* are downwardly biased by the compression spring **21**. When the pistons **18***a* and **18***b* are in the lower positions as shown in FIG. **3**, the lower surface of the lower piston **18***a* is brought into contact with the outer circumferential surface of the exhaust rocker shaft **4**, and at the same time, the outer circumferential surface of the upper piston **18***b* is exposed from the operation window **22** of the cylinder portion **48** in the rightward direction. If the pistons **18***a* and **18***b* are in the upper positions as shown in FIG. **4**, the run-off **23** of the upper piston **18***a* is exposed from the operation window **22** in the rightward direction.

The members including the lower piston **18***a*, the upper piston **18***b*, the cap **19**, the compression spring **21** and the like are commonly used to be accommodated in the exhaust-side cylinder portion **48** and in the intake-side low-speed cylinder portion **16**.

As illustrated in FIGS. **2** and **3**, the exhaust drive rocker arm **49** (fifth rocker arm) is located in front of the exhaust driven rocker arm **43** on the exhaust rocker shaft **4** and pivotably supported on the exhaust rocker shaft **4**. The exhaust drive rocker arm **49** has a configuration symmetrical to the intake-side low-speed drive rocker arm **32**.

The exhaust drive rocker arm **49** will be roughly described with the same reference numerals as those for the low-speed drive rocker arm **32**. The exhaust drive rocker arm **49** is biased by a bias spring, not shown, in the valve-closing direction through the bias portion **33***a*, to thereby bring the roller **35**, which is provided in the right side thereof, into contact with the exhaust cam **7**. Extending from the exhaust drive rocker arm **49** in the rear direction is the operation arm portion **36**. The operation arm portion **36** has the tip end that is bent leftward to have an L-shape, to thereby face the operation window **22** of the cylinder portion **48** of the exhaust driven rocker arm **43**. The exhaust drive rocker arm **49** is oscillated along the shape of the exhaust cam **7** while rotating the roller **35**. In the base circular zone of the exhaust cam **7**, the exhaust drive rocker arm **49** is oscillated in the valve-closing direction to separate the tip end of the operation arm portion **36** from the operation window **22** in the rightward direction as shown by a solid line in FIG. **4**. In the lift zone of the exhaust cam **7**, the exhaust drive rocker arm **49** is oscillated in the valve-opening direction to insert the tip end of the operation arm portion **36** into the operation window **22** as shown by a chained double-dashed line in FIG. **4**.

According to the present embodiment, a second switching mechanism M2 is constituted by the lower and upper pistons **18***a* and **18***b* of the cylinder portion **48**, and the operation arm portion **36** of the exhaust drive rocker arm **49**.

Descriptions about the valve gear for one cylinder of the suspension cylinder bank have been completed. The other cylinders each have a configuration identical to the aforementioned one.

Oil Path

Referring to FIGS. **1** and **2**, an oil path **51** for cylinder suspending mode and an oil path **52** for high-speed mode are formed in the intake rocker shaft **3** along the axial direction thereof. The oil paths **51** and **52** each have front and rear ends that are open in front and rear end surfaces of the intake rocker shaft **3**, respectively. The front end of the oil path **51** is sealed with a plug **53**, and one end of an L-shaped metal pipe **54** is pressed and fixed into the rear end of the oil path **51**. The front end of the oil path **52** is connected to an oil control valve (which serves as control means and is hereinafter referred to as OCV) **55** for high-speed mode via an oil supply path, not shown, formed in the cylinder head **1**. The rear end of the oil path **52** is blocked with a plug **56**.

In the exhaust rocker shaft **4**, an oil path **57** for cylinder suspending mode is formed along the axial direction of the shaft **4**. The oil path **57** has front and rear ends that are open in front and rear end surfaces of the exhaust rocker shaft **4**, respectively. The front end of the oil path **57** is connected to an OCV **58** for cylinder suspending mode via an oil supply path, not shown, formed in the cylinder head **1**. One end of an L-shaped metal pipe **59** is pressed and fixed into the rear end of the oil path **57**. The other ends of the intake-side and exhaust-side metal pipes **54** and **59** face each other with a prescribed distance therebetween and interfitted with respective ends of a rubber hose **60** to be connected to each other.

The OCV **55** for high-speed mode and the OCV **58** for cylinder suspending mode receive oil supply from a lubricating oil pump, not shown, provided to the engine, and are switching-controlled by an ECU **61** (which serves as control means and is an abbreviation for "engine control unit") that is mounted on the vehicle, to thereby appropriately supply oil to the oil path **52** for high-speed mode and the oil path **57** for cylinder suspending mode.

As illustrated in FIGS. **2** and **3**, communication paths **63** are formed in three places (drawings show only one) of the intake rocker shaft **3** to correspond to the low-speed cylinder portions **16** of the intake driven rocker arms **11** of the cylinders concerned. Each communication path **63** has a lower end communicating with the oil path **51** for cylinder suspending mode and an upper end that is open in the outer circumferential surface of the intake rocker shaft **3** and communicates with the lower cylinder **16***a* of each low-speed cylinder portion **16**.

Referring to FIGS. **2** and **5**, communication paths **64** are formed in three places (drawings show only one) of the intake rocker shaft **3** to correspond to the high-speed cylinder portions **17** of the intake driven rocker arms **11** of the cylinders concerned. Each communication path **64** has a lower end communicating with the oil path **52** for high-speed mode and an upper end that is open in the outer circumferential surface of the intake rocker shaft **3** and communicates with the cylinder **17***a* of each high-speed cylinder portion **17**.

As is clear from FIGS. **2** and **3**, communication paths **65** are formed in three places (drawings show only one) of the exhaust rocker shaft **4** to correspond to the cylinder portions **48** of the exhaust driven rocker arms **43** of the associated cylinders. Each communication path **65** has a lower end communicating with the oil path **57** for cylinder suspending mode and an upper end that is open in the outer circumferential surface of the exhaust rocker shaft **4** and communicates with the lower cylinder **16***a* of each cylinder portion **48**.

Non-Suspension Cylinder Bank

A valve gear of a non-suspension cylinder bank has no cylinder suspending mechanism and has only a switching mechanism for switching between the low-speed mode and the high-speed mode. A concrete configuration of the valve gear of a non-suspension cylinder bank will be described hereinafter. In the intake side, the low-speed cylinder portions **16** of the intake driven rocker arm **11** and the low-speed drive rocker arm **32** are not provided (the high-speed cylinder portions **17** and the high-speed drive rocker arm **38** are maintained). The intake driven rocker arm **11** is oscillated directly by the low-speed cam **6** without the medium of the low-speed drive rocker arm **32**, to thereby open and close the intake valve all the time.

In the exhaust side, the cylinder portion **48** of the exhaust driven rocker arm **43** and the exhaust drive rocker arm **49** do not exist. Therefore, the exhaust driven rocker arm **43** is oscillated directly by the exhaust cam **7** without the medium of the exhaust drive rocker arm **49**, to thereby open and close the exhaust valve all the time. Since the intake and exhaust driven rocker arms **11** and **43** are constantly oscillated as stated, the suspension cam **8** of the camshaft **2** is not provided, either. Furthermore, the lack of the cylinder suspending mechanism entails the absence of the oil paths **51** and **57** for cylinder suspending mode, which are to be located in the intake and exhaust rocker shafts **3** and **4**.

The following description is about an operating state of the valve gear with a cylinder suspending mechanism of the engine, which is configured in the aforementioned manner.

Switching control of the OCVs **55** and **58** is carried out by the ECU **61**, based on engine speed Ne. For instance, the cylinder suspending mode (third mode) is activated in a rotation range where the engine speed Ne is less than a first threshold value Ne1, and an output demand to the engine is adequately low. The low-speed mode (first mode) is activated in a rotation range where the engine speed Ne falls in the range between the first threshold value Ne1 and a second threshold value Net (>Ne1), and ordinary engine output is required. The high-speed mode (second mode) is activated in a rotation range where the engine speed Ne is equal to or greater than the second threshold value Net, and particularly high engine output is required. Hereinafter, the operating state of the valve gear will be described with respect to each mode.

Low-Speed Mode

In the suspension cylinder bank, the ECU **61** switching-controls the OCV **55** for high-speed mode and the OCV **58** for cylinder suspending mode and discontinues the oil supply to the oil path **51** for cylinder suspending mode and the oil path **52** for high-speed mode.

As a result, in the low-speed cylinder portion **16** of the intake driven rocker arm **11** and the cylinder portion **48** of the exhaust driven rocker arm **43**, the lower pistons **18***a* and the upper pistons **18***b* are held in the lower positions by a biasing force of the respective compression springs **21**, and the outer circumferential surfaces of the upper pistons **18***b* are exposed through the respective operation windows **22**, as shown in FIG. **3**. As shown in FIG. **5**, in the high-speed cylinder portion **17** of the intake driven rocker arm **11**, the biasing force of the compression spring **28** holds the piston **25** in the lower position, and the run-off **30** is then exposed through the operation window **29**.

During the operation of the engine, the low-speed drive rocker arm **32**, the high-speed drive rocker arm **38**, and the exhaust drive rocker arm **49** are constantly oscillated along the shapes of the corresponding cams **6**, **7**, and **9**. Along with the oscillation, the tip ends of the operation arm portions **36** and **41** are inserted into and separated from the operation windows **22** and **29** of the driven rocker arms **11** and **43**.

The high-speed drive rocker arm **38** independently strikes at the air with the tip end thereof inserted into and separated from the run-off **30** that is exposed through the operation window **29** of the high-speed cylinder portion **17**. The high-speed drive rocker arm **38** does not oscillate the driven rocker arms **11** and **43** as the after-mentioned low-speed drive rocker arm **32** and exhaust drive rocker arm **49** do.

The low-speed drive rocker arm **32** and the exhaust drive rocker arm **49** press the outer circumferential surfaces of the upper pistons **18***b* exposed through the operation windows **22** of the low-speed cylinder portion **16** and the cylinder portion **48** when being oscillated in the valve-opening direction. By so doing, the drive rocker arms **32** and **49** oscillate the corresponding driven rocker arms **11** and **43** in the valve-opening direction, to thereby open the intake and exhaust valves. When the low-speed drive rocker arm **32** and the exhaust drive rocker arm **49** are oscillated in the valve-closing direction, the corresponding driven rocker arms **11** and **43** receive the biasing force of the valve springs, which is produced along with the closing of the intake and exhaust valves, and are then oscillated in the valve-closing direction.

Consequently, the intake driven rocker arm **11** is oscillated with the low-speed drive rocker arm **32** to open and close the intake valves along the shape of the low-speed cam. The exhaust driven rocker arm **43** is oscillated with the exhaust drive rocker arm **49** to open and close the exhaust valves along the shape of the exhaust cam.

In the non-suspension cylinder bank, since the ECU **61** discontinues the oil supply to the oil path **52** for high-speed mode from the OCV **55** for high-speed mode, the high-speed drive rocker arm **38** strikes the air as is the case with the suspension cylinder bank. Thus, the intake valves are driven to open and close along the shape of the low-speed cam **6**, and the exhaust valves along the shape of the exhaust cam **7**. As a consequence, in the low-speed mode, the engine output required within the ordinary rotation range is realized by using the low-speed cam **6** and the exhaust cam **7**.

Cylinder Suspending Mode

While stopping the oil supply to the oil path **52** for high-speed mode in the suspension cylinder bank and the non-suspension cylinder bank, the ECU **61** supplies oil from the OCV **58** for cylinder suspending mode in the suspension cylinder bank.

The oil running from the OCV **58** flows through the oil path **57** of the exhaust rocker shaft **4** from the front side to the rear side to be supplied into the lower cylinder **16***a* of the exhaust driven rocker arm **43** via each communication path **65**. The oil subsequently passes through the metal pipes **54** and **59** and the hose **60**, and then flows through the oil path **51** of the intake rocker shaft **3** from the rear side to the front side. Eventually the oil is supplied into the lower cylinder **16***a* of the intake driven rocker arm **11** via each communication path **63**.

In the lower cylinders **16***a* and the upper cylinders **16***b* of the intake driven rocker arm **11** and the exhaust driven rocker arm **43**, the lower pistons **18***a* and the upper pistons **18***b* slide upward in response to hydraulic pressure of the supplied oil, resisting the compression spring **21**, to be switched to the respective upper positions. This movement exposes the run-offs **23** of the lower pistons **18***a* through the respective operation windows **22**. Therefore, the low-speed drive rocker arm **32** and the exhaust drive rocker arm **49** independently strike the air with the respective tip ends inserted into and separated from the run-offs **23** exposed through the operation windows **22** of the corresponding driven rocker arms **11** and **43**, to thereby halt the oscillating operation with respect to the driven rocker arms **11** and **43**.

Since the high-speed drive rocker arm **38** also strikes at the air, in each cylinder of the suspension cylinder bank, the intake and exhaust valves are kept closed due to the biasing force of the valve springs, and the intake driven rocker arm **11** and the exhaust driven rocker arm **43** are held at valve-closing positions while the sliding-contact portions **15***a* and **47***a* of the cam-side arms **15** and **47** are in contact with the suspension cam **8**.

In the non-suspension cylinder bank, the operation of each cylinder is continued as in the low-speed mode, and the vehicle is operated by torque generated in the non-suspension cylinder bank. At the same time, the suspension of each cylinder in the suspension cylinder bank makes it possible to cut back on fuel consumption.

High-Speed Mode

In the suspension cylinder bank, the ECU **61** discontinues the oil supply to the oil path **51** for cylinder suspending mode from the OCV **58** for cylinder suspending mode, and on the other hand supplies oil to the oil path **52** for high-speed mode from the OCV **55** for high-speed mode.

In consequence, as in the low-speed mode, the outer circumferential surfaces of the upper pistons **18***b* are exposed through the respective operation windows **22** in the low-speed cylinder portion **16** of the intake driven rocker arm **11** and the cylinder portion **48** of the exhaust driven rocker arm **43**.

The oil flowing in the oil path **52** is supplied through the communication path **64** into the cylinder **17***a* of the high-speed cylinder portion **17** in the intake driven rocker arm **11** of each cylinder. In the cylinder **17***a,* the piston **25** slides upward in response to the hydraulic pressure of the supplied oil, resisting the compression spring **28**, to be switched to the upper position. The outer circumferential surface of the piston **25** is then exposed through the operation window **29**.

As a result, in the exhaust side, the exhaust driven rocker arm **43** is oscillated with the exhaust drive rocker arm **49** along the shape of the exhaust cam **7**, and the exhaust valve is driven to be open and close along the shape of the exhaust cam **7** as in the low-speed mode.

In the intake side, the pistons **18***b* and **25** of the low-cylinder portion **16** and the high-speed cylinder portion **17** are both exposed, and therefore can be pressed by the corresponding drive rocker arms **32** and **38**. However, only the high-speed drive rocker arm **38** actually performs the pressing operation, and the low-speed drive rocker arm **32** strikes the air. This is because the high-speed cam **9** has a wider lift zone (or operation angle) and a greater lift amount, compared to the low-speed cam **6**. In short, the intake valve is driven to be open and close along the shape of the high-speed cam **9** in the high-speed mode.

In the non-suspension cylinder bank as well as the suspension cylinder bank, oil is supplied to the oil path **52**, and the intake valves are driven to be open and close along the shape of the high-speed cam **9**. Consequently, in the high-speed mode, high engine output required in the high rotation range is realized by extending an opening period of the intake valves or by increasing the lift amount thereof, compared to the low-speed mode.

The valve gear with a cylinder suspending mechanism of the engine according to the present embodiment operates as stated above. According to the present embodiment, the low-speed drive rocker arm **32** and the high-speed drive rocker arm **38** are arranged in front and at the rear of the intake driven rocker arm **11** as stated, and the low-speed cylinder portion **16** and the high-speed cylinder portion **17** are disposed side by side in the intake driven rocker arm **11**. Moreover, according to the sliding positions of the lower piston **18***a* and the upper piston **18***b* slidably fitted into the low-speed cylinder portion **16** and the piston **25** slidably fitted into the high-speed cylinder portion **17**, the operation arm portions **36** and **41** extending from the low-speed drive rocker arm **32** and the high-speed drive rocker arm **38** are caused to perform pressing operation or to strike the air.

The exhaust drive rocker arm **49** is located in front of the exhaust driven rocker arm **43**, and the cylinder portion **48** is provided in the exhaust driven rocker arm **43**. According to the sliding positions of the lower piston **18***a* and the upper piston **18***b* slidably fitted into the cylinder portion **48**, the operation arm portion **36** extending from the exhaust drive rocker arm **49** is caused to perform the pressing operation or to strike at the air.

As a consequence, in the intake side, the members, such as the low-speed cylinder portion **16**, the high-speed cylinder portion **17**, the low-speed drive rocker arm **32**, and the high-speed drive rocker arm **38**, are efficiently arranged around the intake driven rocker arm **11** to gather in one place. In the exhaust side, the members including the exhaust drive rocker arm **49** and the like are efficiently arranged around the exhaust driven rocker arm **43** to gather in one place. Therefore, the configuration of the valve gear including the cylinder suspending mechanism can be well-organized in the cylinder head **1**, which makes it possible to achieve not only the downsizing of an entire valve gear mechanism but also the downsizing of the engine.

Furthermore, with the result that the members of the valve gear mechanism are arranged to gather in one place, the cylinder portions **16, 17,** and **48** of the driven rocker arms **11** and **43** and the drive rocker arms **32, 38,** and **49** are inevitably made closer to one another, and the tip ends of the operation arm portions **36** and **41** extending from the drive rocker arms **32, 38,** and **49** then face the cylinder portions **16, 17,** and **48** at the substantially shortest distance. Therefore, the operation arm portions **36** and **41** can be reduced to the minimum in length. Consequently, it is possible to decrease the weight of the drive rocker arms **32, 38,** and **49** while ensuring enough strength by forming these arms into efficient shapes, which encourages a reduction in inertial weight of the entire valve gear.

According to the present embodiment, the sliding-contact portions **15***a* and **47***a* of the cam-side arm portions **15** and **47** of the intake driven rocker arm **11** and the exhaust driven rocker arm **43** are brought into contact with the common suspension cam **8** in the cylinder suspending mode. Factors in achievement of the above configuration, and operation and advantages obtained due to the configuration will be described below in detail.

As is obvious from FIGS. **2** and **7**, the low-speed and high-speed drive rocker arms **32** and **38** are located in front and at the rear of the intake driven rocker arm **11**, and the exhaust drive rocker arm **49** in front of the exhaust driven rocker arm **43**. Disposed in between the low-speed cam **6** and the high-speed cam **9** for driving the low-speed and high-speed drive rocker arms **32** and **38** are the exhaust cam **7** for driving the exhaust drive rocker arm **49** and the suspension cam **8** for cylinder suspending mode.

Since the exhaust cam **7** is so located as to substantially correspond to the exhaust drive rocker arm **49** in the axial direction of the camshaft **2**, there is formed a dead space on the camshaft **2** at the position corresponding to the exhaust driven rocker arm **43**, and the suspension cam **8** is disposed in the dead space.

In consequence of the application of the above layout, it is possible to open and close the intake and exhaust valves according to the mode switches by means of the driven rocker arms **11** and **43** that individually function. Furthermore, it is also possible-to bring the sliding-contact portions **15***a* and **47***a* of the cam-side arm portions **15** and **47** extending from the intake and exhaust driven rocker arms **11** and **43** into contact with the common suspension cam **8**. As a result, there simply has to be provided the single suspension cam **8** per cylinder on the camshaft **2**. This makes it possible to shorten the entire length of the camshaft **2** and to reduce man-hours required to manufacture the camshaft **2**, thereby lowering the cost of production, in comparison with the engine disclosed in Japanese provisional patent publication No. 2002-201921, which requires a pair of suspension cams per cylinder.

The suspension cam **8** may be narrow in view of the function if it simply serves to control the oscillation of the driven rocker arms **11** and **43**. Due to restrictions for the processing of a cam, however, the suspension cam **8** needs to be located at some distance from an adjacent cam. To be concrete, in order to avoid interference of a grindstone with the adjacent cam when the suspension cam **8** is polished or in order to facilitate the work of removing burr of the polished cam, there needs to be a space between the suspension cam **8** and the adjacent cam. Therefore, each of the suspension cams **8** requires a considerable occupied space in the axial direction of the camshaft **2**, and moreover as many occupied spaces as cylinders are required. Unlike the valve gear disclosed in the above Publication No. 2002-201921 which requires a pair of suspension cams per cylinder, the valve gear of the present embodiment functions by using the single suspension cam **8**, and therefore, the entire length of the camshaft **2** can be shortened to a large degree.

Furthermore, not only the cams **6** through **9** located on the camshaft **2** but also the intake and exhaust driven rocker arms **11** and **43** and the intake and exhaust drive rocker arms **32**, **38** and **49** can be efficiently arranged without waste. This makes it possible to achieve the downsizing of the entire valve gear and therefore to accomplish the downsizing of the engine as well.

Additionally, in the layout of the above-described valve gear, the boss portion **12** of the intake driven rocker arm **11** and the boss portion **44** of the exhaust driven rocker arm **43** partly overlap each other as shown in FIG. **7**. In other words, the intake and exhaust driven rocker arms **11** and **43** substantially face each other with the suspension cam **8** therebetween, so that the cam-side arm portions **15** and **47** extending from the boss portions **12** and **44** cause the sliding-contact portions **15***a* and **47***a* to contact the suspension cam **8** at the substantially shortest distance. Consequently, the weight of the intake and exhaust driven rocker arms **11** and **43** can be reduced while enough strength thereof is secured by forming these arms into efficient shapes at the same time, and the inertial weight of the entire valve gear can be reduced.

The operation arm portions **36** and **41** of the low-speed drive rocker arm **32**, the high-speed drive rocker arm **38**, and the exhaust drive rocker arm **49** are so formed as to extend along the axial direction of the camshaft **2**. The operation arm portions **36** and **41** have the respective tip ends bent into an L-shape toward the corresponding cylinder portions **16**, **17**, and **48**, to thereby face the operation windows **22** and **29**. Accordingly, as is the case with the cam-side arm portions **15** and **47** of the driven rocker arms **11** and **43**, the operation arm portions **36** and **41** of the drive rocker arms **32**, **38**, and **49** have the respective tip ends facing the operation windows **22** and **29** of the cylinder portions **16**, **17**, and **48** at the substantially shortest distance. This reduces the weight of the drive rocker arms **32**, **38**, and **49** while ensuring enough strength by forming these arms into efficient shapes, which encourages a reduction in the inertial weight of the entire valve gear.

Although the explanation of the embodiment has been completed, the form of the present invention is not limited to the above embodiment. For instance, the invention is applied to the V-six cylinder gasoline engine having four valves per cylinder in the above embodiment. As long as the engine is one having a valve gear with a cylinder suspending mechanism, however, the engine does not have to be a V-six cylinder gasoline engine in terms of category and type. On the contrary, the invention may be applied to for example a diesel engine or an in-line four-cylinder engine having two valves per cylinder.

According to the embodiment, the cylinder suspending mechanism is provided to not only the intake side but also the exhaust side in the suspension cylinder bank, and the exhaust valve is kept closed while the cylinder suspending mode is activated. For instance, however, the exhaust driven rocker arm **43** may be oscillated directly by the exhaust cam **7** without the cylinder suspending mechanism of the exhaust side.

In the embodiment, not only the piston **25** of the high-speed cylinder portion **17** but also the upper piston **18***b* of the low-speed cylinder portion **16** is exposed to enable the pressing operation in the high-speed mode. However, only the piston **25** of the high-speed cylinder portion **17** is actually pressed. Therefore, it is not necessary to expose the upper piston **18***b* of the low-speed cylinder portion **16**, and the upper piston **18***b* may be maintained in the upper position which exposes the run-off **23**.

According to the embodiment, the exhaust drive rocker arm **49** is supported in front of the exhaust driven rocker arm **43**, and the exhaust cam **7** and the suspension cam **8** are disposed on the camshaft **2** to correspond to the rocker arms **43** and **49**. However, the rocker arms **43** and **49**, and also the cams **7** and **8**, may be located the other way around in the longitudinal direction. In this case, too, it is still possible to achieve exactly the same operation and advantages as in the layout of the valve gear described in the embodiment.

Furthermore, in the embodiment, the pistons **18***a*, **48***b*, and **25** provided to the intake and exhaust driven rocker arms **11** and **43** are pressed or not pressed by using the operation arms **36** and **41** of the drive rocker arms **32**, **38**, and **49**, to thereby oscillate the driven rocker arms **11** and **43** according to the mode switches. The configurations of the first and second switching mechanisms, however, are not limited to the above-mentioned configuration. For instance, like the engine disclosed in the above Publication No. 2002-201921, the drive rocker arms **32**, **38**, and **49** and the driven rocker arms **11** and **43** may be connected with or disconnected from one another with switch pins that slide in the axial direction of the camshaft **2**.

What is claimed is:

1. A valve gear with a cylinder suspending mechanism of an internal combustion engine, comprising:

- a first rocker arm having a tip end connected to either one of an intake valve and an exhaust valve and pivotably supported on a first rocker shaft;
- a second rocker arm located at one side of said first rocker arm, pivotally supported on said first rocker shaft, and driven by a first cam formed in a camshaft;
- a third rocker arm located at the other side of said first rocker arm, pivotally supported on said first rocker shaft, and driven by a second cam formed in the camshaft and having a cam shape different from said first cam;
- a first switching mechanism for switching connection and disconnection of said first rocker arm with respect to said second or third rocker arm; and
- control means for controlling the switching of said first switching mechanism, wherein
- said first switching mechanism includes a first piston slidably fitted into a first cylinder formed in said first rocker arm, a second piston slidably fitted into a second cylinder formed in said first rocker arm, a first engaging projection extending from said third rocker arm and formed to be engageable with said second piston, and a second engaging projection extending from said third rocker arm and formed to be engageable with said second piston; and
- said first and second pistons are switched between an engaging position and a non-engaging position with respect to said first and second engaging projections.

2. The valve hear with a cylinder suspending mechanism of an internal combustion engine according to claim **1**, wherein said control means controls the switching of said first switching mechanism so as to activate any one of a first mode in which said first rocker arm is driven by said first cam, a second mode in which said first rocker arm is driven by said second cam, and a third mode in which said first rocker is rendered inoperative.

3. The valve gear with a cylinder suspending mechanism of an internal combustion engine according to claim **2**, wherein

said control means controls the switching of said first switching mechanism, such that in said first mode, said first piston is located in the engaging position with respect to said first engaging projection, and said second piston in the non-engaging position with respect to said second engaging projection, and

in said third mode, said first piston is located in the non-engaging position with respect to said first engaging projection, and said second piston in the non-engaging position with respect to said second engaging projection.

4. A valve gear with a cylinder suspending mechanism of an internal combustion engine, comprising:

a first rocker arm having a tip end connected to either one of an intake valve and an exhaust valve and pivotably supported on a first rocker shaft;

a second rocker arm located at one side of said first rocker arm, pivotably supported on said first rocker shaft, and driven by a first cam formed in a camshaft;

a third rocker arm located at the other side of said first rocker arm, pivotably supported on said first rocker shaft, and driven by a second cam formed in the camshaft and having a cam shape different from said first cam;

a fourth rocker arm having a tip end connected to the other one of the intake valve and the exhaust valve and pivotably supported on a second rocker shaft that is disposed in parallel to said first rocker shaft;

a fifth rocker arm located adjacent to said fourth rocker arm, pivotably supported on said second rocker shaft, and driven by a third cam;

a first switching mechanism for switching connection and disconnection of said first rocker arm with respect to said second or third rocker arm;

a second switching mechanism for switching connection and disconnection of said fourth rocker arm and said fifth rocker arm; and

control means for controlling the switching of said first and second switching mechanisms,

wherein, said first switching mechanism includes a first piston slidably fitted into a first cylinder formed in said first rocker arm, a second piston slidably fitted into a second cylinder formed in said first rocker arm, a first engaging projection extending from said second rocker arm and formed to be engageable with said first piston, and a second engaging projection extending from said third rocker arm and formed to be engageable with said second piston, and said first switching mechanism switches said first and second pistons between an engaging position and a nonengaging position with respect to said first and second engaging projections, and

said second switching mechanism includes a third piston slidably fitted into a third cylinder formed in said fourth rocker arm and a third engaging projection extending from said fifth rocker arm and formed to be engageable with said third piston, and switches said third piston between an engaging position and a non-engaging position with respect to said third engaging projection.

5. The valve gear with a cylinder suspending mechanism of an internal combustion engine according to claim **4**, wherein said control means controls the switching of said first and second switching mechanisms so as to activate any one of a first mode in which said first rocker arm is driven by said first cam, and said fourth rocker arm by said third cam, a second mode in which said first rocker arm is driven by said second cam, and said fourth rocker arm by said third cam, and a third mode in which said first and fourth rocker arms are rendered inoperative.

6. The valve gear with a cylinder suspending mechanism of an internal combustion engine according to claim **5**, wherein

said control means controls the switching of said first and second switching mechanisms, such that in said first mode, said first piston is located in the engaging position with respect to said first engaging projection, and said second piston in the non-engaging position with respect to said second engaging projection, and said third piston in the engaging position with respect to said third engaging projection,

in said second mode, at least said second piston is located in the engaging position with respect to said second engaging projection, and said third piston in the engaging position with respect to said third engaging projection, and

in said third mode, said first piston is located in the non-engaging position with respect to said first engaging projection, and said second piston in the nonengaging position with respect to said second engaging projection, and said third piston in the non-engaging position with respect to said third engaging projection.

7. The valve gear with a cylinder suspending mechanism of an internal engine according to claim **4**, wherein

said second cam is formed on the camshaft at a location away from said first cam in an axial direction,

said third cam is formed in between said first cam and said second cam of said camshaft, and

a fourth cam is formed in between said first or second cam and said third cam in said camshaft, and said first rocker arm and said fourth rocker arm are biased to contact a circumferential surface of said fourth cam.

8. The valve gear with a cylinder suspending mechanism of an internal combustion engine according to claim **7**, wherein a first support portion of said first rocker arm associated with said first rocker shaft and a second support portion of said fourth rocker arm associated with said second rocker shaft are so arranged as to partly overlap each other with said fourth cam therebetween.

9. The valve gear with a cylinder suspending mechanism of an internal combustion engine according to claim **8**, wherein said first support portion has a first contact portion formed to extend from said first support portion toward said second support portion above said fourth cam, and said second support portion has a second contact portion formed to extend from said second support portion toward said first support portion above said fourth cam in order not to interfere with said first contact portion.

10. The valve gear with a cylinder suspending mechanism of an internal combustion engine according to claim **9**, wherein when said first and second pistons are located in the respective non-engaging positions with respect to said first and second engaging projections by using said first switching mechanism, and at the same time said third piston is located in the non-engaging position with respect to said third engaging projection by using said second switching mechanism, said first and fourth rocker arms are brought into contact with the circumferential surface of said fourth cam to be kept suspended.

11. The valve gear with a cylinder suspending mechanism of an internal combustion engine according to claim **4**, wherein said first, second, and third engaging projections

extending from said second, third and fifth rocker arms in an axial direction of the camshaft, respectively, and are each formed into an L-shape that swerves from an axis of the camshaft to be bent and elongated toward said first, second and third pistons, respectively.

12. The valve gear with a cylinder suspending mechanism of an internal combustion engine according to claim **7**, wherein said first rocker arm and said fourth rocker arm are arranged side by side on said fourth cam so as to overlap each other, as viewed in the axis direction of the camshaft.

13. A valve gear with a cylinder suspending mechanism of an internal combustion engine, comprising:

a first rocker arm having a tip end connected to either one of an intake valve and an exhaust valve and pivotably supported on a first rocker shaft;

a second rocker arm located at one side of said first rocker arm, pivotally supported on said first rocker shaft, and driven by a first cam formed in a camshaft;

a third rocker arm located at the other side of said first rocker arm, pivotally supported on said first rocker shaft, and driven by a second cam formed in the camshaft and having a cam shape different from said first cam;

a first switching mechanism for switching connection and disconnection of said first rocker arm with respect to said second or third rocker arm; and

control means for controlling the switching of said first switching mechanism,

wherein, said first switching mechanism includes a first piston slidably fitted into a first cylinder formed in said first rocker arm, a second piston slidably fitted into a second cylinder formed in said first rocker arm, a first engaging projection extending from said third rocker arm and formed to be engageable with said second piston, and a second engaging projection extending from said third rocker arm and formed to be engageable with said second piston,

said first and second pistons are switched between an engaging position and a non-engaging position with respect to said first and second engaging projections,

wherein said control means controls the switching of said first switching mechanism so as to activate any one of a first mode in which said first rocker arm is driven by said first cam, a second mode in which said first rocker arm is driven by said second cam, and a third mode in which said first rocker is rendered inoperative, and

wherein said control means controls the switching of said first switching mechanism, such that in said first mode, said first piston is located in the engaging position with respect to said first engaging projection, and said second piston in the non-engaging position with respect to said second engaging projection, and

in said third mode, said first piston is located in the non-engaging position with respect to said first engaging projection, and said second piston in the non-engaging position with respect to said second engaging projection.

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